PATENT SPECIFICATION

(11) 1 307 628

DRAWINGS ATTACHED

(21) Application No. 40377/70 (22) Filed 21 Aug. 1970

(19)

(44) Complete Specification published 21 Feb. 1973

(51) International Classification H01R 39/08

(52) Index at acceptance
H2A 2D3A 2D3E 2D3F 2D3G 2D3X

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(54) SLIP RING ASSEMBLY FOR ELECTRICAL MACHINES

(71) We, VEREINIGUNG VOLKSEIGENER BETRIEBE ELEKTRISCHE KONSUMGUTER, a corporation organised under the laws of Eastern Germany, of 6 Alexanderplatz, Berlin, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a slip ring assembly for high-speed electrical machines having slip rings of non-metallic material.

Slip ring assemblies for electrical machines of which the slip rings consist of non-metallic materials, such as carbon, are sufficiently known. One type of slip ring assembly, for instance, is so constructed that the slip rings are embedded in casing resin. These slip rings embedded in casting resin and consisting of carbon, however, are easily liable to burst during the operation of the electrical machine, owing to the difference in the expansion coefficients between the two materials, the entire slip ring assembly thus being rendered inoperative.

In order to prevent this the contact surfaces of the casting resin assembly and of the carbon slip ring were provided with a coating acting as a lubricant, but this is only possible by processes involving the use of considerably expensive apparatus.

Particularly in the use of slip ring assemblies with carbon slip rings in enclosed electrical machines which have to operate, for example, in severe atmospheric conditions, difficulties are known to arise, inasmuch as the heat produced in the slip rings during operation and extending far beyond the permissible limits has to be removed from the machine. This is also important because the different expansion coefficients of the materials used jeopardize the suitability of the entire slip ring assembly for the performance of its function. Various means of solving this technical problem have been tried out in the past.

Constructions are known in which, for the complete compensation of the different expansion coefficients, as between support body and carbon slip rings, the compact support body is replaced by individual cylindrical supporting parts, each consisting of a cylindrical hub with raised parts of the nature of corrugations distributed over the periphery in a rotationally symmetrical manner, the outer surfaces of these corrugated protuberances forming the slip ring supports. In these systems the number of slip ring supports depends on the number of current conducting or clamping bolts employed. Slip ring assemblies of this construction fulfil all the requirements arising during the operation of the electrical machine and remain unaffected by the difference of expansion coefficient between the support body and the carbon slip rings, mainly owing to the fact that these components are only in contact with one another over a very small area, but their production involves considerable expenditure on apparatus. A complicated mould is required for the manufacture of the separate supporting parts. Differences in the dimensions of the slip ring assemblies and in the number of separate slip rings required necessitate corresponding differences in the design of the separate supporting parts and of the moulds for their production, so that the manufacture of slip ring assemblies of this type proves uneconomic despite the technical advantages. A slip ring assembly for high current is also known with which, however, face-ground contacts are used which are fitted by their "contactless" end face and by their outer surface into an annular metal disc. A disadvantage of this slip ring system is the necessity of the complete conversion of the electrical machines to be equipped therewith.

It is an object of this invention to provide a slip ring assembly which will stand up to high currents and temperatures which will

provide satisfactory dissipation of heat, accompanied by compensation of the differences in the expansion coefficients of the individual materials, and which will render the production of all the necessary types and sizes of slip ring assembly more economical than hitherto known.

According to the present invention there is provided a slip ring assembly for high-speed electrical machines, including a cylindrical support hub consisting of an insulating material, slip rings consisting of a non-metallic material being supported on the support hub, holding caps abutting the outermost slip ring end faces of the slip ring assembly, further holding caps or distance rings abutting the other end faces of the slip rings and connecting elements making electrical contact with the slip rings, the support hub and holding caps being in direct thermal contact with each other and being formed of a beryllium oxidic cement or plastics material containing beryllium oxide.

The support hub is provided with axially extending ducts which emerge at the external surface thereof opposite each bearing surface of the slip rings. The ducts which start at one end face of the slip ring assembly are provided for the purpose of accommodating strip-shaped connecting elements which provide electrical contact with the slip rings.

In the case of the slip ring assemblies subjected to more moderate thermal stresses it is sufficient if the holding caps are provided only on the outer end faces of the slip ring assembly delimiting the contact surface of the slip ring assembly, while between the separate carbon slip rings distance rings or spacer tubes are provided which consist of insulating material.

It is also possible for the holding caps to be shaped in the region of their central bore in such a way as to take the form of a cylindrical sleeve, in which case sleeve-shaped attachments of the caps provide the entire support hub of the slip ring assembly to the required length. These sleeve shaped attachments likewise possess ducts to accommodate the strip-shaped connecting elements.

For the dissipation of heat, the maintenance of the required distance, the insulation between the respective parts and also protection against centrifugal forces, only the end faces of the slip ring assembly may be provided with holding caps, whereas between the slip rings, close fitted with complementary or corresponding engaging surfaces, distance rings in the form of spacer tubes, of insulating materials, are arranged concentrically with one another. The strip-shaped connecting elements for the conducting current are attached, by known processes for the provision of contacts, to the internal surface of the slip rings in question, are bent in order to maintain the insulation distance and are brought out of one side of the slip ring body in the axial direction.

The supporting hub may be produced by a process in which the assembly consisting of slip rings, distance rings or spacer tubes and holding caps is filled, particularly by the centrifugal method, with a beryllium-oxidic cement or a plastics material containing beryllium oxide. The correct apportionment of the centrifugal material provides the necessary bore for accommodating the armature shaft.

In the case of comparatively large slip ring assemblies a cylindrical tubular structure may be inserted in the slip ring bore in order to reduce the centrifugal space. For the purpose of internal consolidation the entire slip ring assembly is saturated with a binding agent, such as hardenable resin. The concentrically situated distance rings or spacer tubes are preferably permeable to air, in order to avoid the accumulation of heat. In addition, an electrically non-conductive, heat-conducting material in the form of an organically or inorganically bound material containing beryllium oxide is introduced between the concentrically arranged distance rings or spacer tubes.

Slip rings assemblies of this kind can be rationally produced in all sizes and types. Their construction is characterised by the fact that the slip ring assemblies will stand up to considerable thermal loading. The intensive contact between the slip rings, in which the temperature rise occurs, and the lateral surfaces, via the holding caps, and as a result of the support hub in the bore, as well as the good thermal conduction between the holding caps and the support hub, due to the construction adopted, ensures rapid dissipation of the heat, via the armature shaft, from the enclosure of the machine. This effect is greatly intensified by the use of materials containing beryllium oxide, owing to its high thermal conductivity and good insulating properties. Owing to the use of simple holding caps, distance rings or spacer tubes and the adoption of the centrifugal method, the components of the slip ring assembly can be produced more simply.

From the insulation point of view this construction offers advantages, the strip-shaped connecting elements resting completely in the support hub or in the centrifugal material, both of which have an insulating effect. The close fitting complementary connection between the holding caps, distance rings or spacer tubes, on the one hand, and the slip rings, on the other, provides additional protection against centrifugal forces during use of the electrical machine.

A number of constructional embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a sectional diagram of a 3-part slip ring assembly,

Figure 2 is a sectional diagram of a 3-part slip ring assembly with distance rings provided between the slip rings,

Figure 3 is a sectional diagram of a 3-part slip ring assembly with sleeve-shaped attachments provided on the outer caps,

Figure 4 is an end view corresponding to Figures 1 and 2,

Figure 5 is a partial sectional view with caps engaged,

Figure 6 is a sectional diagram of a 2-part slip ring assembly with centrifuged supporting hub,

Figure 7 is a lateral view corresponding to the above,

Figure 8 is a sectional view of the 2-part slip ring assembly with sleeve-shaped basic structure inserted.

In a slip ring assembly shown in Figure 1 three slip rings 1, 2 and 3 are made of a non-metallic material, such as carbon, and enclosed at both end surfaces in holding caps 4 and 5, which are made of plastics material containing beryllium oxide and of which a collar portion surrounds and engages part of the contact surface of the slip rings 1, 2 and 3. The holding caps 4, 5 and the slip rings, 1, 2, and 3 are provided with a central bore by which they are mounted on a cylindrical support hub 6 likewise consisting of plastics material containing beryllium oxide.

In the wall of the support hub 6 and at one end face thereof, are provided axial ducts 7 which are situated 120° apart from one another as shown in Figure 4. Each of the ducts connects with the outer surface of the support hub 6, in the region, respectively, of one of the three inner surfaces of the slip rings 1, 2 and 3. One of strip-shaped connecting elements 8, 9 and 10 is embedded in each of these ducts 7 and is in contact with the inner surfaces of the slip rings 1, 2 and 3, respectively.

In the case of slip ring assemblies not subjected to such high thermal stresses as the above described slip ring assembly may be subjected, it is sufficient for distance rings 11 to be provided between the slip rings 1, 2 and 3 which distance rings are shaped to engage the slip rings in both radial and axial directions, caps 4 and 5 then being provided only on the end faces of the slip ring assembly, as shown in Figure 2.

The example in Figure 3 shows how the caps 4 and 5 resting or abutting against the end faces of the outer slip rings 1, 3 of the slip ring assembly are provided in their central bore, with sleeve-shaped attachments 12 and 13. The ducts 7, which are situated 120° apart, are provided in the sleeve-shaped attachment 12, in order to accommodate the strip-shaped connecting elements 8, 9 and 10, which provide electrical contact with the slip rings 1, 2 and 3.

In Figure 5 there is shown part of a slip ring assembly in which the collar portion of the holding caps 4, 5 engages peripheral recesses in the slip rings 1, 2 and 3. The slip rings are made with such an outside diameter dimension that they project radially beyond the collar portion of the holding caps.

A further example is shown in Figures 6, 7 and 8.

In this slip ring assembly two slip rings 14 and 15 of non-metallic material are kept apart by two mutually concentric distance rings or spacer tubes 16 and 17 formed of an insulating material. These distance rings in each case engage peripheral recesses 18 provided on the internal and external periphery of the two end faces belonging to the slip rings 14 and 15 and facing towards each other, and provide additional protection for the slip rings 14 and 15 against the centrifugal forces occurring during the operation of an electrical machine. The axial boundaries of the slip ring assembly are formed by holding caps 19 and 20, each of which rests or abuts against one of the outer end faces of the slip rings 14 and 15. One of the holding caps 19 and 20 is provided, in the vicinity of its central bore with two perforations 21 which serve as ducts for strip-shaped connecting elements 22 and 23 which provide electrical contact, for example in the form of electrically conductive adhesive material, with the internal periphery of the slip rings 14 and 15. These strip-shaped connecting elements 22 and 23 are thus brought out of the slip ring assembly in the axial direction, one connecting element 22, being straight and the other connecting element 23 being bent in order to insulate it in respect of the slip ring 14.

This assembly consisting of two slip rings 14 and 15 with strip-shaped connecting elements 22 and 23 formed of electrically conductive material, and of two concentrically situated distance rings 16 and 17 and two holding caps 19 and 20, is centrifuged with a cement or plastics material containing beryllium oxide in order to produce a support hub 24, in which process the apportionment of the appropriate quantity of centrifuging material enables the desired diameter 25 to be obtained for the bore which is to accommodate an armature shaft. Therefore the centrifuged space is formed by the caps 19 and 20, the internal surfaces of the slip rings 14 and 15 and the distance ring 17 which engages the internal periphery of the end faces of the slip rings 14 and 15, which end faces face towards each other.

In the case of slip ring assemblies of larger dimensions it is advisable, in order to reduce the size of the centrifuged space, to insert a cylindrical tube structure 26 (Figure 8).

Satisfactory dissipation of heat is ensured by a perforated construction adopted for the distance ring 16. The distance ring 17 delimiting the centrifuged space has a continuous surface. Particularly satisfactory dissipation of heat can be obtained by the insertion of an electrically non-conductive, heat-abstractive material 27, in the form of an organically or inorganically bound beryllium oxide material, between the slip rings 14 and 15 and the concentrically actuated distance rings 16 and 17. For the purpose of internal consolidation the entire slip ring assembly is saturated with a resin.

The plastics material from which the holding caps and distance rings are formed may exhibit thermoplastics or thermosetting (duroplastic) type characteristics.

WHAT WE CLAIM IS:—

1. A slip ring assembly for high-speed electrical machines, including a cylindrical support hub consisting of an insulating material, slip rings consisting of a non-metallic material being supported on the support hub, holding caps abutting the outermost slip ring end faces of the slip ring assembly, further holding caps or distance rings abutting the other end faces of the slip rings and connecting elements making electrical contact with the slip rings, the support hub and holding caps being in direct thermal contact with each other and being formed of a beryllium oxidic cement or plastics material containing beryllium oxide.

2. An assembly as claimed in claim 1, including three slip rings each mounted on the support hub and each provided with holding caps abutting the end faces thereof.

3. An assembly as claimed in claim 1 or 2, wherein the holding caps abutting the outermost slip ring end faces of the slip ring assembly include axially extending members which together constitute the support hub.

4. An assembly as claimed in any one of claims 1, 2 or 3, wherein the slip rings project radially beyond the holding caps.

5. An assembly as claimed in claim 1, including three slip rings each mounted on the support hub and distance rings separating the slip rings, wherein the distance rings are formed of an insulating material.

6. An assembly as claimed in claim 5, wherein the distance rings are of a T-shaped cross section.

7. An assembly as claimed in claim 5, wherein the distance rings are formed by spacer tubes situated concentrically one relative to the other and wherein the support hub is formed by a centrifuged tubular structure.

8. A slip ring assembly as claimed in claim 7, wherein the spacer tubes are permeable to air.

9. A slip ring assembly as claimed in claim 7, or 8, wherein between the slip rings and within the concentric spacer tubes an electrically non-conductive, heat-abstractive material is provided in the form of an organically or inorganically bound material containing beryllium oxide.

10. A slip ring assembly as claimed in claim 7, 8 or 9, wherein a cylindrical tube structure is provided in the slip ring assembly the centrifuged tubular structure being located between the cylindrical tube structure and the slip rings.

11. An assembly as claimed in any one of claims 7 to 10, wherein the connecting elements are supported in or by the centrifuged tubular structure and project axially from the slip ring assembly through apertures provided in one holding cap.

12. An assembly as claimed in any one of the preceding claims, including substantially axially extending ducts formed in the support hub between one end face of the assembly and the respective ones of the slip rings, the connecting elements being located in the ducts and projecting axially from the slip ring assembly.

13. A slip ring assembly as claimed in any one of the preceding claims, wherein the slip ring assembly is saturated in a binding agent.

14. A slip ring assembly substantially as hereinbefore described with reference to, and as illustrated in the accompanying drawings.

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Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1973.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

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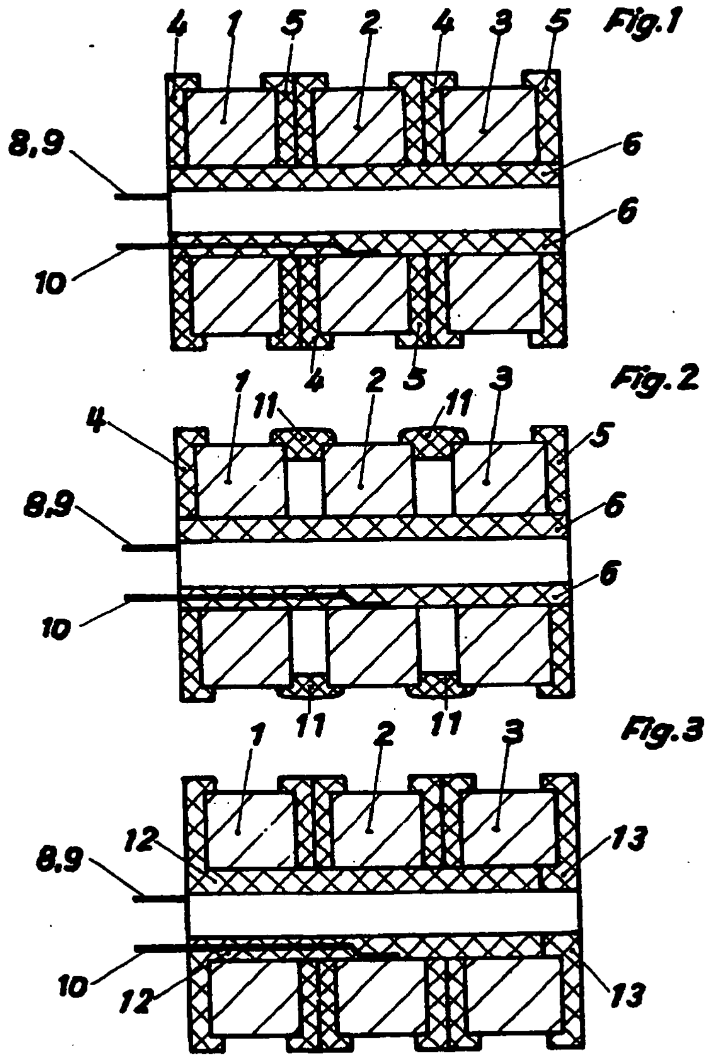
Sheet 1

Fig.1

Fig.2

Fig.3



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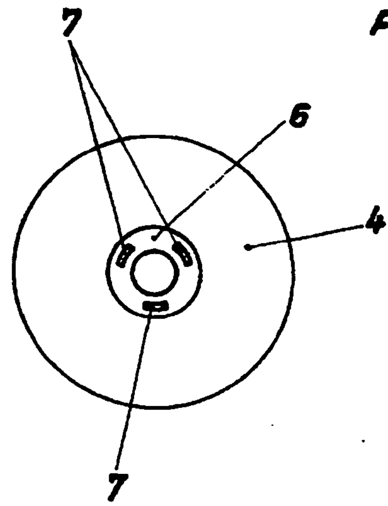

Fig. 4

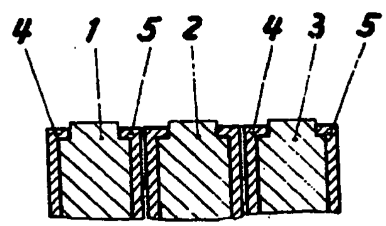

Fig. 5

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Sheet 3

Fig. 6

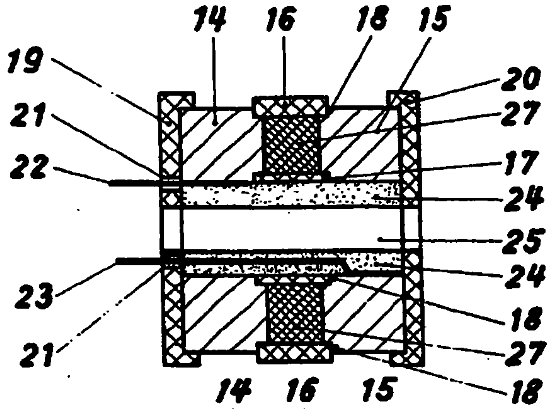

Fig. 7

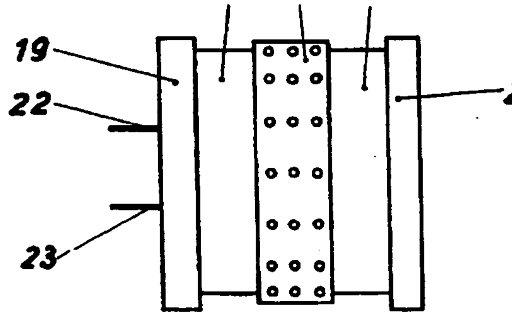

Fig. 8